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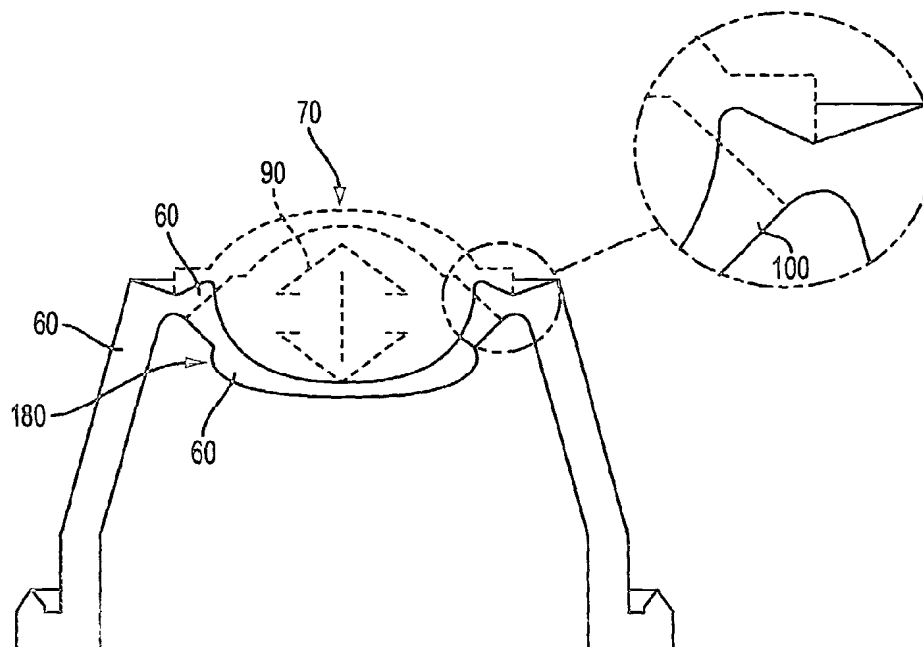
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(54) Title: SELF-CLEANING SHAPE MEMORY RETAINING VALVE



(57) Abstract: A shape memory retaining valve of various formations and material product flow distributions which in conjunction with, for example, a flexible walled container of material product such as a ketchup or mustard container from variations of valve shape, durometer of material forming the valve such as TPE, and valve configuration dispense material product in a valve formation directed manner to form creative shapes and dispersions.



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A. Title of Invention. Self-Cleaning Shape Memory Retaining Valve

B. Cross Reference to Related Applications. None

C. Statement Regarding Federally-Sponsored Research on Development. N/A

D. Reference to Sequence Listing. None

E. Background of the Invention

(1) Field of Invention. The present invention is directed to closures and valves and more particularly to a pressure-activated, self-cleaning shape memory-retaining valve.

(2) Description of Related Art and Information Disclosed Under 37 CFR 1.97 and 37 CFR 1.98

A drawback of known valve top dispensers is the sloppiness of the product dispensed as squeezed from a container well and the subsequent need to clean a cap opening following usage. Without cleanup or proper sealing, there is often left remaining mustard or other types of dispensable products, for example, from a squeeze bottle to dry atop the opening of a container and encrust unhygienically and unsightly, a problem resolved by the disclosed invention.

Thermoplastic Elastomer (TPE) and other material are a diverse family of rubberlike-materials that, unlike conventional vulcanized rubbers, can be processed and recycled like thermoplastic materials. They feature dynamic vulcanization: the process of intimate melt-mixing a thermoplastic polymer and a suitable reactive rubbery polymer to generate a thermoplastic elastomer with a chemically cross-linked rubbery phase, resulting in properties closer to

those of thermoset rubber when compared to the same un-crosslinked composition.

TPEs provide functional performance and properties similar to conventional thermoset rubber products, but can be processed with the speed, efficiency and economy of thermoplastics.

In addition to simpler processing, principal advantages of TPEs compared to thermoset rubber products include easier recycling of scrap and closer, more economical control of dimensions and product quality.

Benefits of TPEs include improved cost/performance, design flexibility, reduced weight, wide service temperature range, ease of processing, superior product quality and dimensional consistency and in-house recyclability.

### **Object and Advantages**

In one embodiment, a valve in conjunction with a flexible-walled container is intended to dispense product in an inverted position but is not limited to this position. The valve can be made from injection molded thermoplastic elastomer (TPE) or other material for ease of manufacture.

In one embodiment, the valve design disclosed provides the functional advantage of being self-cleaning from pressure-activated action based on the molded structure and memory of, for example, the (TPE) material it is comprised of.

Another object of the valve invention disclosed is that it can be utilized for all types of products, under varying conditions and varying amounts of material to be dispensed.

An additional object is the valve's ability to eliminate container paneling achieved in one embodiment by the flexibility of the valve and the design of the

cover cap that is based on a one-way air passageway. An object of the invention is that the valve can be formed and assembled in several different ways and still achieves the same successful dispensing results. From a separate molded piece, the valve can be inserted on or inside a nozzle for example and then locked in place with a retainer. The injected molded valve can also be co-injected or insert molded directly and formed on or into the nozzle, when used with compatible material.

Other objects and advantages of the present invention will become apparent from the following descriptions, taken in connection with the accompanying drawings, wherein, by way of illustration and example, varying embodiments of the present invention are disclosed.

#### F. Summary of the Invention

These and other objects of the invention, which shall become hereinafter apparent are achieved by a Self-Cleaning Shape Memory Retaining Valve. The valve has a self-cleaning and self-sealing shape, retaining initial molded shape memory following a pressure-activated deformation and is preferably comprised of selected material comprising injection molded thermoplastic elastomer (TPE) or material which retains initial molded shape following the deformation of the initial molded shape from the material flow pressure from the container. The valve has reduced or eliminated container paneling for the container further comprising a cover cap based on at least a one-way air passageway. Further the valve has at least a molded piece and is inserted proximate to a nozzle and has further a retainer for positional locking in one embodiment.

#### G. Brief Description of the Drawings

The invention will be better understood by the Detailed Description of the varying embodiments, with reference to the drawings, in which:

FIG. 1A is an example of a top view of the pressure-activated self-cleaning valve, with in one embodiment centermost slitting;

FIG. 1B is an example of a side view of the pressure-activated self-cleaning valve made from, for example, TPE for flexibility, with a “living” hinge flexible action shown activated from pressure upon the slitting;

FIG. 2 is an example of a side view of the valve shown from an example with hinged rings in a concave position;

FIG. 3A is an example of a side view of the valve showing an air intake valve, with an air way from an example position of the valve, with the cap in a down position to keep the valve from dispensing such that the valve flexes down and air is let in;

FIG. 3B1 is another example of the valve from a side view in position over a base cap with a top cover cap closed;

FIG. 3B2 is a top view of the valve with a cap in place;

FIG. 3C1 is a side view showing a ship and storage position with the base cap in position with, for example, two air slots;

FIG. 3C2 is a top view showing a valve without a cover cap in position;

FIG. 4 is an example side view of the pressure-activated intake valve;

FIG. 5 shows an equalized dispensing controlled directional dispensing from a variation of the slitting formation of a valve;

FIG. 6 shows a valve formation variation, with the valve initially concave;

FIG. 7 shows a valve formation variation, with the valve with curved slits for a dispensing shape to create, for example, a spiral dispensing pattern from a valve;

FIG. 8 shows a valve formation variation, with a valve of unequal sides with a lunar dispensing shape;

FIG. 9 shows variations of the directional dispensing valves with variant shapes of open and closed positions; and

FIG. 10 shows variations of the equalized dispensing valves with variant shapes of open and closed positions.

#### H. Detailed Description

Referring now to the drawings wherein like numerals reflect like elements throughout the various views, in one embodiment, a valve can be

formed with several rings of thick (60) and thin (40) wall sections as shown in FIG. 1A that are precisely spaced and formed to provide connecting circular hinges (50) controlled when external pressure is applied to the walls of a container.

In FIG. 1A, a top view of the “pressure-activated self-cleaning valve,” is shown with the features of a center slit (20) with hinges (30) which are flexible. Across the valve is a thinned out ring area formed by the thin wall section (40) with circular hinged rings (50) formed as well.

The selection of a lower durometer TPE material, for example, enables and magnifies the valve’s ability to expand and retract in a cycle (90) (FIG. 1.B) and seal with less external wall pressure.

FIG. 1B in a side view of the pressure-activated self-cleaning valve which shows here a thickened ring area (60). The FIG. 1B shows the valve convex (70) and the valve concave retracted (80) and the up and down action of circular hinged rings (90). An exploded view action of the hinged swing rings is shown.

Each of the molded rings within the valve disclosed is synchronized to perform a specific function when external pressure is applied to the walls of the container. The circular rings within the valve become flexible and expandable “living” hinges (100) as shown in FIG. 1B. The expansion of the valve controls the product to be dispensed by insuring that the entire center section of the valve becomes convex (70), enabling the slit (20) in one embodiment or perforated holes in another embodiment to stretch and expand open. When the slits are forced into the expanded convex position (70), they are unlocked and able to open outwardly. This transition reverses the angles created by the expanded convex shape (70). Perforated holes or slits that are normally self-sealing in the concave (80) position of the disclosed invention stretch open and

dispense when in the convex (70) or outward position. Variation of valve design affects the tooling layout, valve size, molded slit, slitting or piercing operation of the valve and placement of the gate for an infinite variation of dispensing possibilities.

FIG. 2 is a Side View of the pressure-activated self-cleaning valve showing a spherical radian surface (91) of the underside of the valve. This radian can be spherical as shown on the subsequently flat varying radian diameter (92) as shown by element 92 between points L and M with varying offset (93) for this example of the valve having as well exterior sharp corners (101) as shown in this example embodiment.

After dispensing, for example, the valve snaps back almost immediately, thus cutting off the product flow caused by the rebound of the container walls reforming to the original molded state. During this transition of retraction to the concave (80) position, leftover product within the center of the outer valve is drawn back and sucked into the main container in one embodiment. This self-cleaning action is possible due to the valve's ability to open inwardly even with the cover cap in place (see Figs. 3C1 and FIG. 4).

FIG. 3A is a side view air intake valve with, in one embodiment, a cap, here as shown with the cap (212) in the down position-keeping valve from dispensing. As shown, the valve can flex down (216) to allow air flow in the valve through an air way (218).

FIG. 3B2 shows a top view, with the cap (212) in place. FIG. 3B1 shows top cap in place, from a side view.

For example as shown in FIG. 3C1, a side view is presented showing a ship and storage position with the base cap in position with, for example, two



air slots with FIG. 3C2 providing a top view showing a valve without a cover cap in position.

FIG. 3C2 provides a top view of the valve without a cover cap in place. FIG. 3C1 shows a side view of the valve with cap (212) in position the top cover cap (212) and valve in a ship and storage position with air slot (s) (242) can be provided as part of the valve above the base cap (244).

FIG. 4 is side view of the pressure-activated intake valve showing the valve with a cap in place such that the inner portion of the cover cap acting with the valve which is stopped from opening outwardly; the concave valve “living hinges” extending with the valve open concavely inwardly with air flow provided.

FIG. 4 shows a side view embodiment of the pressure-activated air intake valve with the flexible hinge(s) (410) flexing such that the concave valve opens inwardly (420). Air flow (430) is shown thru the airway (218) with cap (212) stopping the valve from opening outwardly with the inner portion (450) of cover cap (212) over the (460) valve.

After dispensing the product, the self-cleaning valve action can be assisted if the container is placed or held in an upright position or placed on a level surface during the container sidewall recovery, thus allowing product to clear. The container walls reform outwardly to a normal molded position after being squeezed, creating a reverse airflow that refills the vacated inner container space. The cleaning action is automatic after each squeeze of the container as part of the valve retraction cycle. During retraction of the reverse airflow, as the valve returns to the concave (80) position, the base pocket of the

valve is sucked back into the container walls and its original shape. In the absence of negative or positive pressure on the container, the valve will automatically return to its original molded shape. The valve has excellent resiliency to environmental factors such as temperatures, altitudes, and material product variations of consistency.

Molding the slit, cutting or piercing operations can be done in the mold during or after the assembly process of the disclosed invention. In one example, the molded valve composed from TPE can take up to twenty-four hours of cure time before slitting. In some instances, slitting the valve prematurely can produce a substandard valve and prevent proper sealing. The type of slit or piercing along with the durometer of the (TPE) material is determined by the type of product to be dispensed. The valve, when used with a flexible walled container, can work very well with thinner valve walls and a lower durometer of (TPE) materials as well.

When dispensing liquids, lower durometer (TPE) is much easier to flex as it requires much less hand strength and enhances the economics of the valve for a larger market. More extreme environments present unique conditions, causing products to thicken or become thinner. Products that are kept in the refrigerator and left out for a time may change qualitatively in the way they dispense along with the hand pressure required to dispense. Certain products may require a special slit, slit length, special slit shaping (variations are shown throughout Figures 9 and 10) or softer durometer based on changing environments, which can easily be configured and foreseeable for the disclosed invention.

As shown in FIG. 9, variations of the directional dispensing valves, with variant shapes of open and closed positions can direct material flow creatively from valve formation variation. For example a closed position directional dispensing valve shape variation of opposite curves is shown (920). The (922)

open position directional dispensing valve shape variation is then shown. A closed position (924) four curve slit is shown in open position (926) and a closed position (928). An open position (930) wider curve set is shown in a closed position (932) and in an open position (934). A closed position (936) off-center curve is shown achieving a semi-lunar open position (938). A closed position (940) narrow short slit is shown, followed by a semi-oval open position (942) as well as the closed position (944) centralized variation of holes is shown in an expanded open position (946). A closed position zig zag (948) is shown in an open position (950) for zig zag dispensing material as well.

As shown in FIG. 10, variations of the equalized dispensing valves with variant shapes of open and closed positions are shown such that if the slit or perforations are in the exact center of a valve face, then a gate will be placed slightly off center. If the slit or perforations are off center then the gate can be centered. FIG. 10 shows equalized dispensing valves variation samples. For example, a closed position shape valve variation of a center single slit opens to an open position (1022) shape valve variation of semi-oval shape. A closed position (1024) cross slit achieves a four point “petal” open position (1026) for dispensing. An X-shaped closed position slitting (1028) of equalized dispensing achieves an open position four pointed polygonal (1030) for dispensing material. A variation of closed position slit centering achieves a form of multi-inverted curve (1032) shown in an open position (1034). A closed position burst slitting (1036) achieve a flower petal open position shape (1038) distribution. A closed position (1040) “T”-variation slitting achieves an open position (1042) rectangular dispensing variation. A closed position (1044) “transom” slitting achieves a semi-rectangular open position (1046) for dispensing. A closed position dual “mountain” profile slitting (1048) achieves an open position (1051). The number of novel unique shape dispensing configurations due to unique valve variation equalized shape for dispensing is multifold.

Some (TPE) material is listed with extremely high mold shrinkage rates. The differential can be as much as 39% or more in (“X”) direction of flow, versus the (“Y”) direction transverse to material flow direction. This differential can affect the valve’s basic ability to function, as it creates integral stresses within the wall structure itself. The stress factor becomes even more apparent after slitting and dispensing various products. The gate placement and size as earlier shown in Figures 9 and 10, is a factor in creating a valve with similar amounts of material stress within the face of the valve. Extreme wall stress variations cause the valve slit to open on one side first and close last, creating an uneven dispensing challenge. In some cases, the unequalled stress factors will cause one side or section of the same valve to be stronger or weaker compared to the other. Because the slit material could be expanding and flexing more on one side, the product will be forced to dispense unevenly. Slitting the valve off-center or placing the slit closer to one sidewall will also produce uneven dispensing and product cut-off.

Molding slits can be designated to close after the initial molding process, based on the material flow, directional shrinkage and gate positioning.

Additionally FIG. 8 shows an example of dispensing shape embodiment with the directional side dispensing created by unequal sides getting and slitting. The center gate of this embodiment (810) has a weak side (812) strong side (814) dispensing shape embodiment (816) achieving dispensing (818) with the off center slit dispensing material flow to the strong side (844).

This kind of wall imbalance will cause product to be dispensed toward the strong side because of the weak flap or fingers opening first and wider, forcing the product in a diagonal or angular dispensing pattern. FIG. 8 shows a valve formation variation, with a valve of unequal sides having a lunar dispensing shape 816. This configuration creates a shaped dispensing (818) pattern with the slit off the center gate of the valve (810). The controlled

direction of material dispensing to the strong side (814) of the valve is away from the weak side (812) of the valve and expands and dispenses (818) with unequal curved flaps 816, creating a directed action upon material flow from the difference of flexing of the stronger side (814) and the substantially weaker side (812) flexing unequally on expansion of the valve (818) dispensing. When the valve closes and the product is shut off by the weak side of the slit, angular dispensing becomes most obvious at this point.

Curved slits or flaps will produce turning or circular dispensing patterns because of the unopposed forces of the expanded directional flap opening and closing. Irregularities around the slit are magnified because of the expansion and stretching of the (TPE) material. Slitting or piercing concave valves on the side wall radius result in product being dispensed away from center because of the valve expandings and reversing, becoming concave. Valves which are not cut or slit cleanly have a tendency to “hang-up” and not open and close smoothly and product leakage is more likely. Unintended “side” dispensing can also be caused by one side of the slit or flap not being neutralized by an equal force or identical isometric flap on the exact opposite 180° side.

The dispensing direction of the valve is controlled by the material’s ability to expand and recover simultaneously, including the slits (20) or flaps. In one embodiment, by placing the gate directly in the center of a round valve produces equal stresses—that is, if the wall thickness is generally consistent and isometric. Slitting directly across the molded gate mark is not generally preferred, nor center gating as it can sometimes cause the slit to hang-up and not open or close properly.

In another embodiment, by placing the gate slightly off-center, slits can be made directly over center with minimal inherent stress problems affecting product dispensing.

An achievement of material distribution, for example dispensing foods or art materials, can be uniformly dispensed from the novel invention's design and structure. Simple foods such as hot dogs with mustard can end up looking much more appetizing with a creative or uniform pattern dispensed over its visual surface, achieved by the control offered by the disclosed invention. The various slits contour and outline shaping (as shown throughout in FIGs 5 –10 discussed below), along with practice can make some very interesting dispensing patterns from the disclosed invention. Consumers can create different dispensing results of thick or thin lines and visuals and even form letters. Dispensing products which retain their shape after dispensing are visually rewarding. This type of product valve pattern enhancement of the invention can be used for product presentation or as a marketing tool for making products look extraordinary, to an endless variation of dispensable products valve-controlled in formation with easy clean up.

For example, FIG. 5 shows equalized dispensing controlled directional dispensing from a variation of the slitting formation of a valve with, for example, a straight line dispensing pattern (516) with equal, centered flaps (518), which are center-gated with equal slits (514), providing a straight line dispensing pattern with a dispensing shape (511) shown from the “living” hinges flexing. The figure shown is an example of the controlled directional dispensing (517) of material flow achieved with the injection molded valves. The sample dispensing shape (511) (as shown in this one sample embodiment) achieve equalized dispensing (517) with equal flaps (518) for the straight dispensing of material flow through valve equal slits (514) of this one sample embodiment with the center slit (20) with center gating (516) of slits (20) as shown. Centered flap(s) (518) achieve straight dispensing of material flow through this embodiment.

FIG. 6 shows a valve formation variation, in which the valve is initially concave 610, and then expanding to a convex position. The concave valve (610) shape (80) embodiment has a center gate (612) embodiment with hole(s) (615). At a convex valve (70) position the holes (615) expand (614) flexibly such that material dispenses in an arc and to the sides move away from the center (617) this is because of the shape (610) of the valve.

For example, FIG. 7 shows a valve formation variation, with the valve having curved slits for a dispensing shape to create, for example, a spiral dispensing pattern from a valve; the figure 7 showing a curved slits embodiment to create spiral dispensing patterns. By having a curved shaped center gate (710) with a weak side (712) and a (714) strong side of varying thickness or, in another example, consistent thickness and varying the durometer of the material as well as the unique dispensed shape embodiment (716) shown here as dispensing (718) with expanded from unequal curved flaps creating a twisting action on material flow in this sample embodiment.

In one embodiment, the valve cover cap is designed to enable a reverse air flow to enter the container when the cover cap is in the closed position, as shown in FIG. 4 (430). This one way directional airflow of the disclosed invention eliminates the problem of flexible walled containers being distorted and held in a concave position or what is known in the art as paneling. This challenging problem is sometimes caused by hot-filled products which are sealed in airtight containers and experience radical temperature changes. This type of problem can also be created by altitude changes. After consumers dispense product and snap the cover cap over the valve before the container walls are fully recovered, the inward airflow continues into the valve. The valve, cap and hinge design allows the container and valve walls to completely recover in the disclosed invention. FIG. 3A is an example of a side view of the valve showing an air intake valve, with an air way from an example position of

the valve, with the cap in a down position to keep the valve from dispensing such that the valve flexes down and air is let in. FIG. 3B1 is another example of the valve shown from a side view in position over a base cap with a top cover cap closed. FIG. 3B2 is a top view of the valve with a cap in place. The top cover cap restricts the valve from opening out. However the valve can open inwardly and it automatically lets air in when pressure from the flexible walled container reforms to its original shape.

While the preferred and alternate embodiments of the invention have been depicted in detail, modifications and adaptations may be made thereto, without departing from the spirit and scope of the invention, as delineated in the following claims:



CLAIMS

1. A pressure-activated dispensing and self-cleaning valve for product packaging having a discharge opening therein, said valve comprising:

a valve portion shaped to selectively seal the discharge opening of a container following deformation;

a valve head portion, having an orifice which opens and closes to control material flow, and being shaped to self clean in an axial direction with respect to a marginal valve portion;

a connector sleeve portion, said connector sleeve portion having one marginal end area thereof connected with said marginal valve portion connected with said valve head portion; and

a flexible valving construction to apply radially inwardly directed forces to said valve head portion which assists in securely retaining said orifice closed as selected, said valve head having an orifice which opens and closes due to hinge shape retention of said valving construction to control material flow and being shaped to self-clean following dispensing.

2. A squeeze-to-open, cap and a pressure-activated dispensing and self-cleaning construction for hand-held dispensers, comprising in combination:

a) a body member having a discharge passage;

b) a valve member carried by the body member and being pressure-deformed from material flow thereon between a flexible valving construction sealing position and a discharge position for material dispensing through an orifice,

c) said valving construction on said members for interrupting communication between the discharge passage and the discharge orifice when a nozzle member is disposed in its raised, sealing position, and for establishing an opening between the container interior for material discharge passage through said orifice when the valve member is disposed in a discharging position such that said material can flow through the discharge passage and said valving construction and out through the discharge orifice of the valve member; and

d) said valving construction reforming initial shape formation in a raised, sealing position in the absence of a force applied to the valve member.

3. The valve of claim 1, wherein said valve is formed by modifying said valving construction aspects, comprising

at least a valving construction size;

a valving construction slitting;

a valving construction piercing;

a valving construction gate placement;

at least one of a ring formation and a valving construction wall section thicknesses on said valve.

4. The valve of claim 3 wherein said valving construction comprises sections forming connecting circular hinges controlled with pressure applied to said container.

5. The valve of claim 3, wherein said ring formations on said valve stretch in response to external pressure application to said container wall.
6. The valve of claim 1 wherein said valve is formed from a selection of material comprising (TPE) thermoplastic elastomeric material.
7. The valve of claim 6, wherein said valve is made of a low durometer material.
8. A valve of claim 7, used with said container wherein said valve comprising said valving construction with at least a thin valving wall of said low durometer material for dispensing a liquid material flow.
9. A valve of claim 1 further wherein said flexible valving construction is formed with a stress factor to cause at least one of a section of said valving construction to be relatively stronger relative to at least one of a weaker section of said valving construction responsive to a material flow stress.
10. The valve of claim 9 wherein said flexible valving construction forms a slit further comprising a slit placement proximate to at least a selected sidewall of said valve to produce a material flow change and a material flow cut-off responsive to said material flow stress.
11. A valve of claim 1, further comprising:

a section of said valve becoming at least a convex shape enabling at least an opening comprising at least one of a slit or at least one of a perforated hole of said valve portion to stretch and expand open;

wherein said valve expands to said convex shape such that said material flow dispenses when transitioning to said valve convex shape from a valve self-sealing concave shape.

12. A valve which retains shape memory after dispensing to discontinue product flow by the rebound of valve walls said valve further comprising

a container with container walls reforming to an initial molded memory state of an initial molded form;

wherein said valve which in a transition of retraction to a concave position draws back a product flow within a position of an outer valve and outside a container wall via retraction of said valve walls.

13. A valve of claim 12 further comprising a cap further comprising a cap attachment to said container.

14. A valve as in claim 12 with said valve walls further comprising a valve wall formation of at least a flap, a finger, or a slit for guiding said material flow to a pattern.

15. The valve of claim 12 wherein said valve walls formations is of a shape to determine said material flow pattern comprising curves, lines, angles, and points.

16. The valve of claim 12 further wherein said valve walls are formed by slitting or piercing a concave valve on a side wall radius resulting in said

valve with said material flow dispensed away from relatively center of said valve.

17. A valve of claim 12 further wherein said material flow is controlled by a durometer of a valve formation further

said valve comprising

a gate placed at center of said valve to produce equal stresses in said material flow;

and said valve further comprising said valve walls of a consistent wall thickness.

18. The valve of claim 12 further wherein

said valve comprises a cap designed to reverse air flow to enter a container when said cap is in a closed position.

19. The valve of claim 12 further wherein

said valve in conjunction with said container comprises a one way directional airflow structure to eliminate a container distortion.

20. The valve of claim 12 further wherein said valve is formed via molding comprising injection molding, co-injected molding or direct insertion molding of said valve;

further wherein said valve is formed on a nozzle.

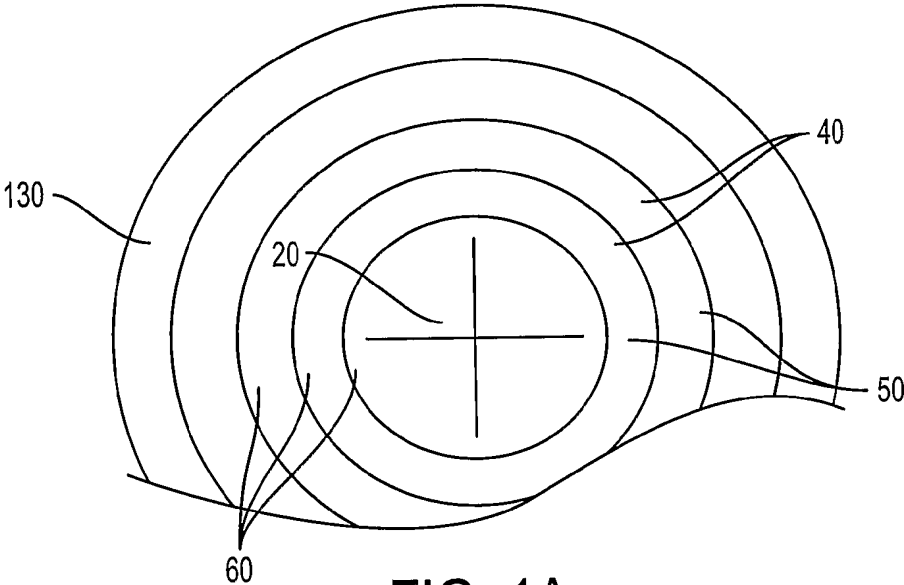


FIG. 1A

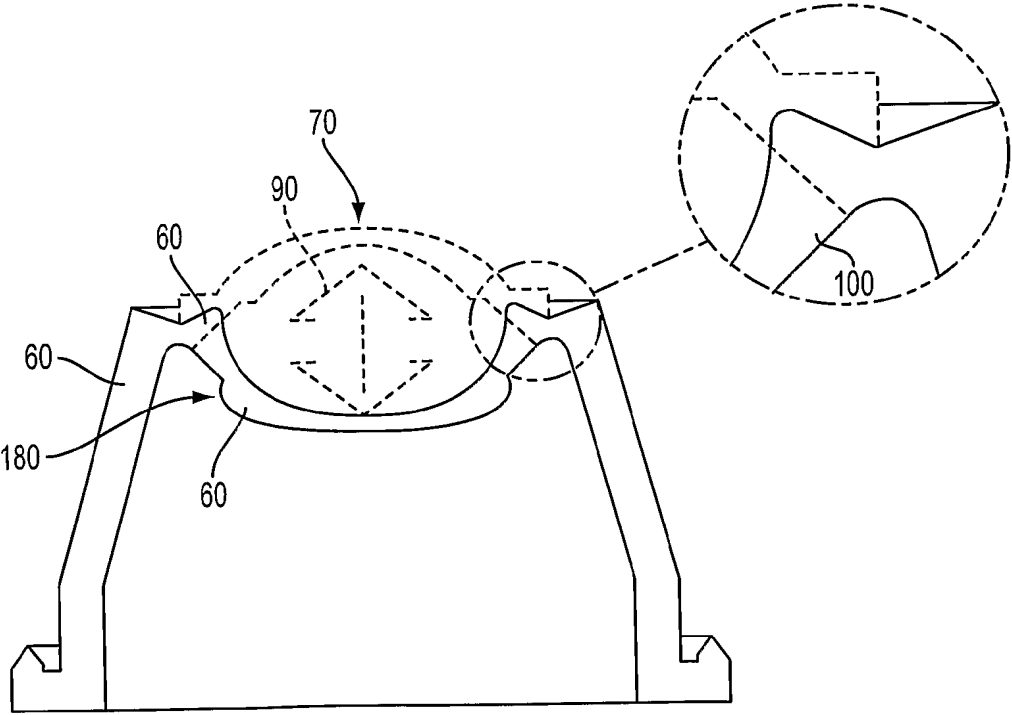


FIG. 1B



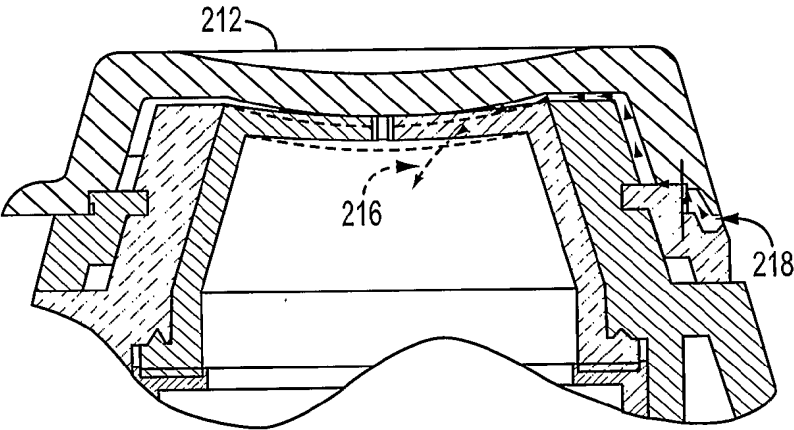


FIG. 3A

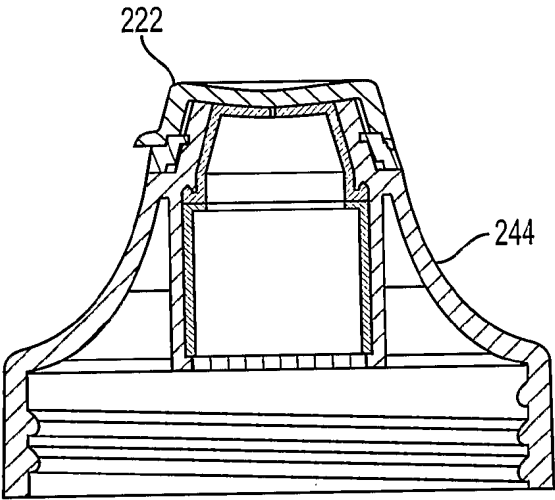


FIG. 3B1

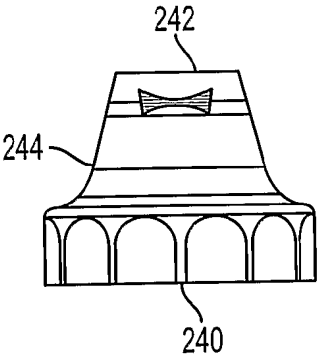


FIG. 3C1

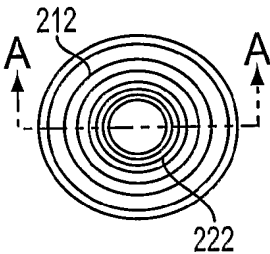


FIG. 3B2

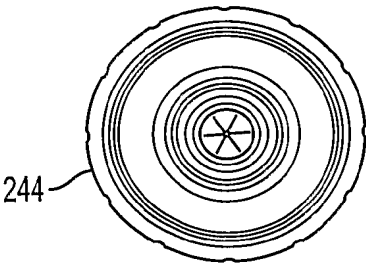


FIG. 3C2



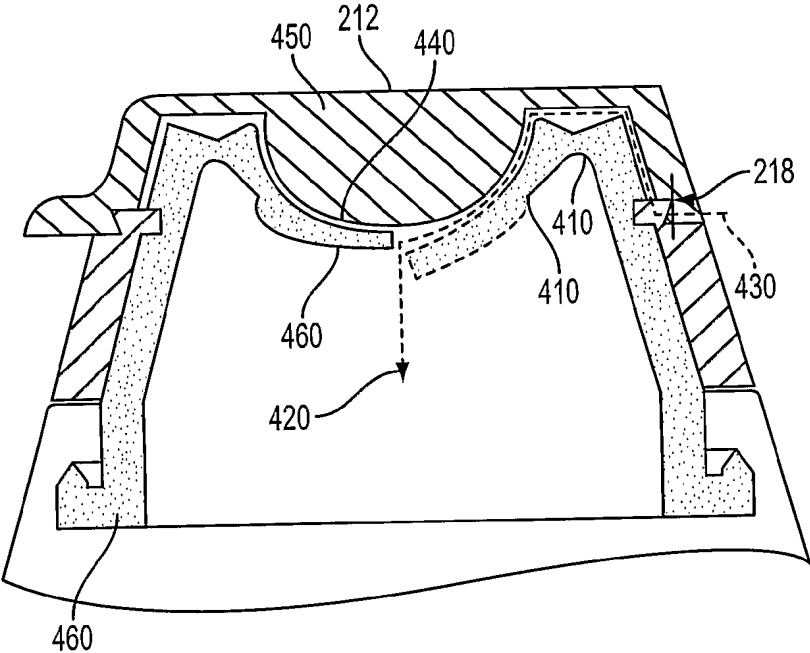


FIG. 4

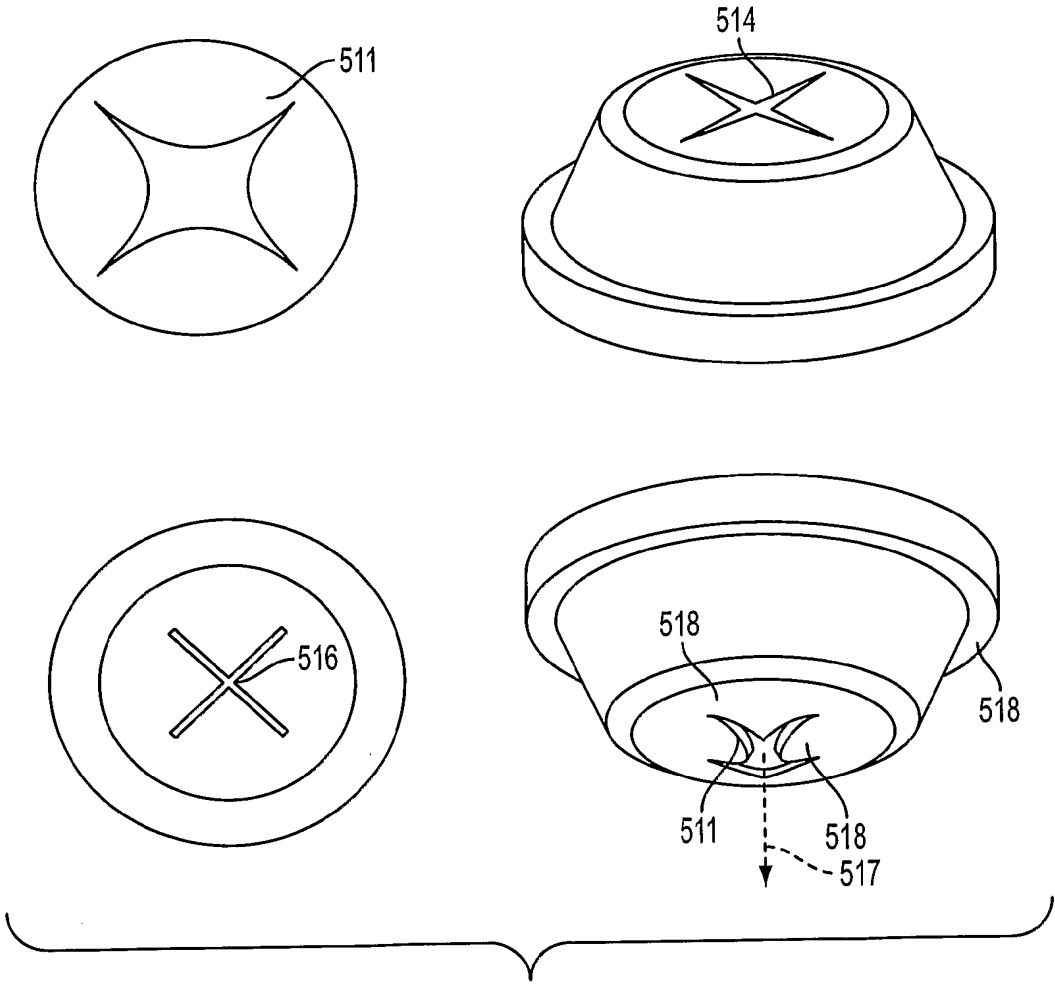


FIG. 5

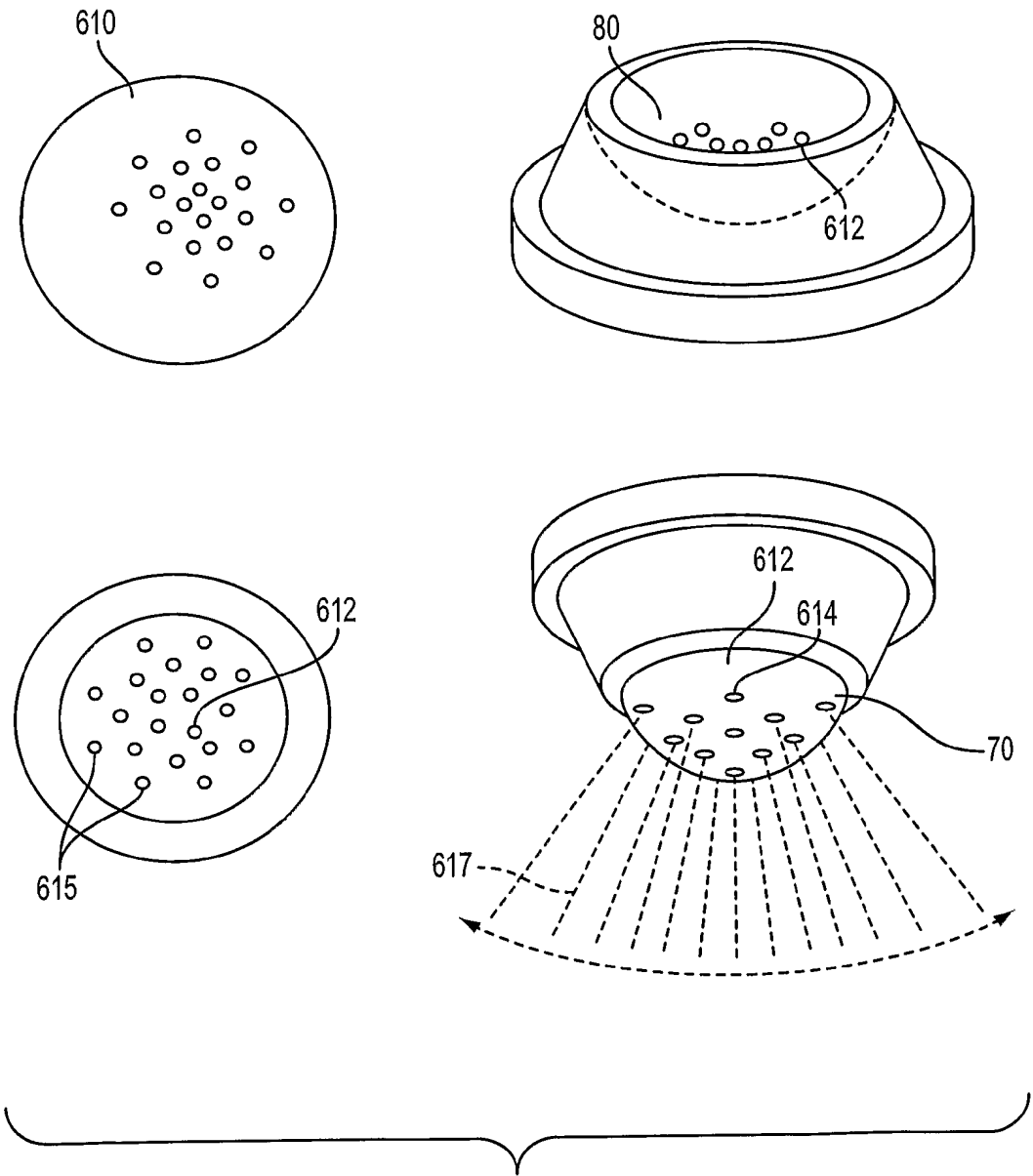


FIG. 6

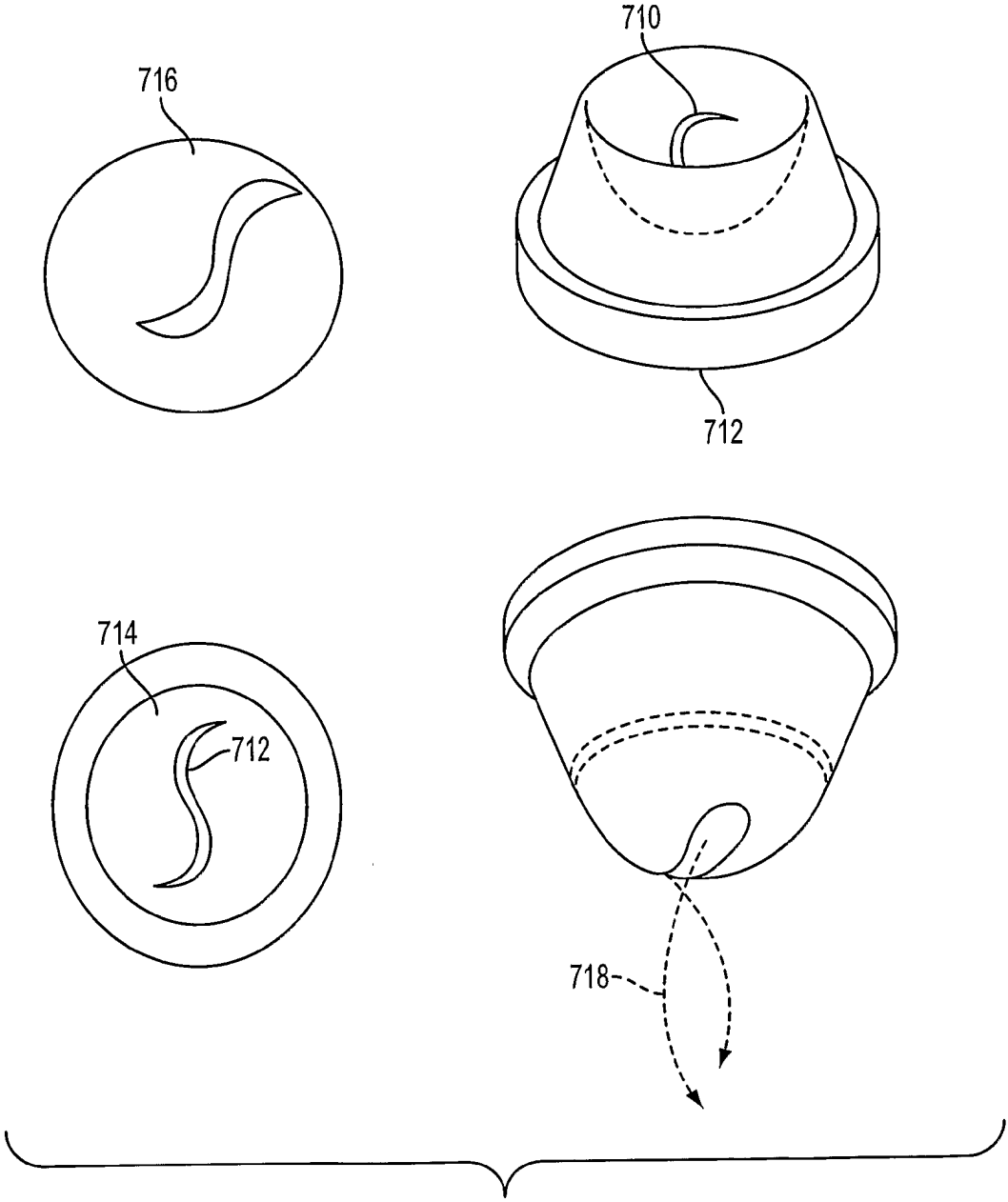


FIG. 7

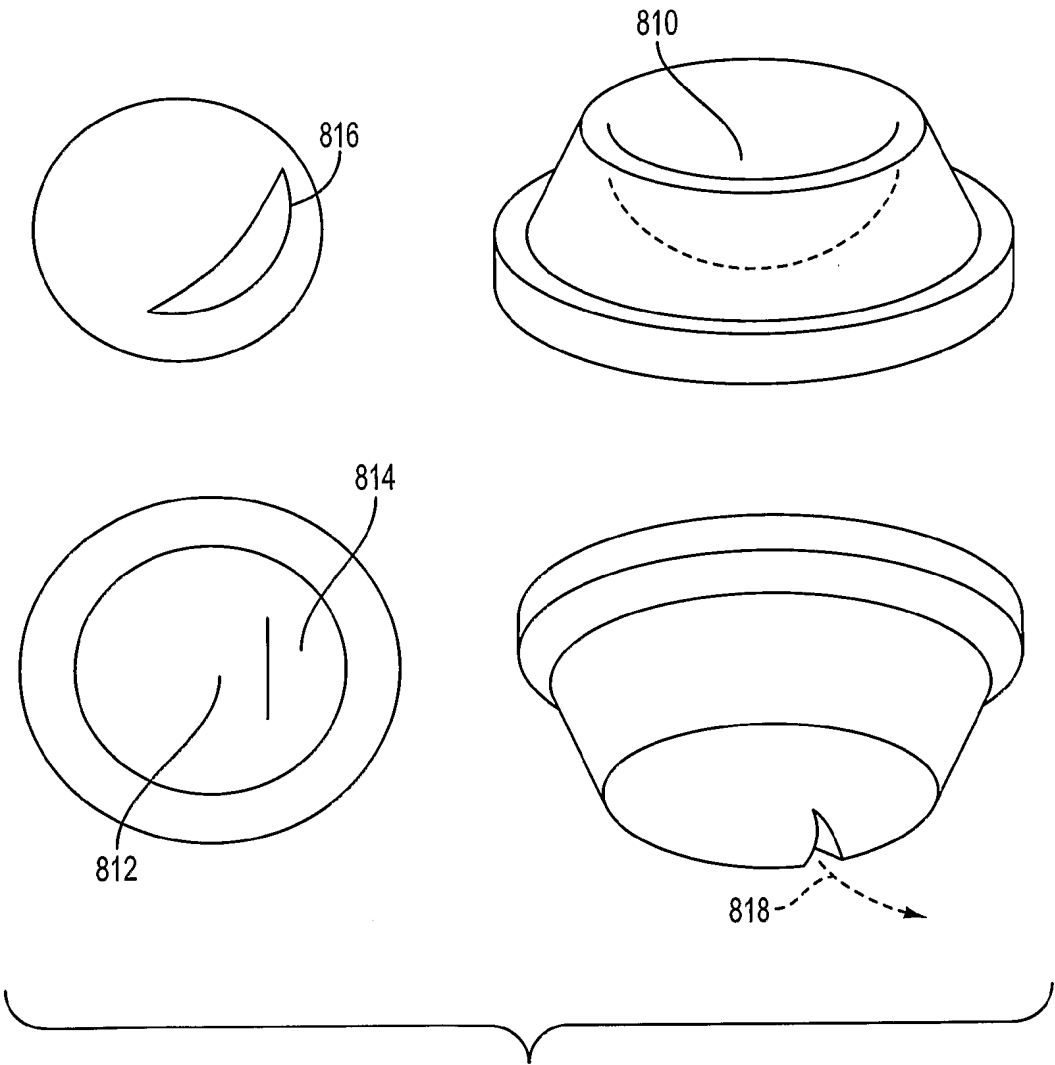


FIG. 8



FIG. 9

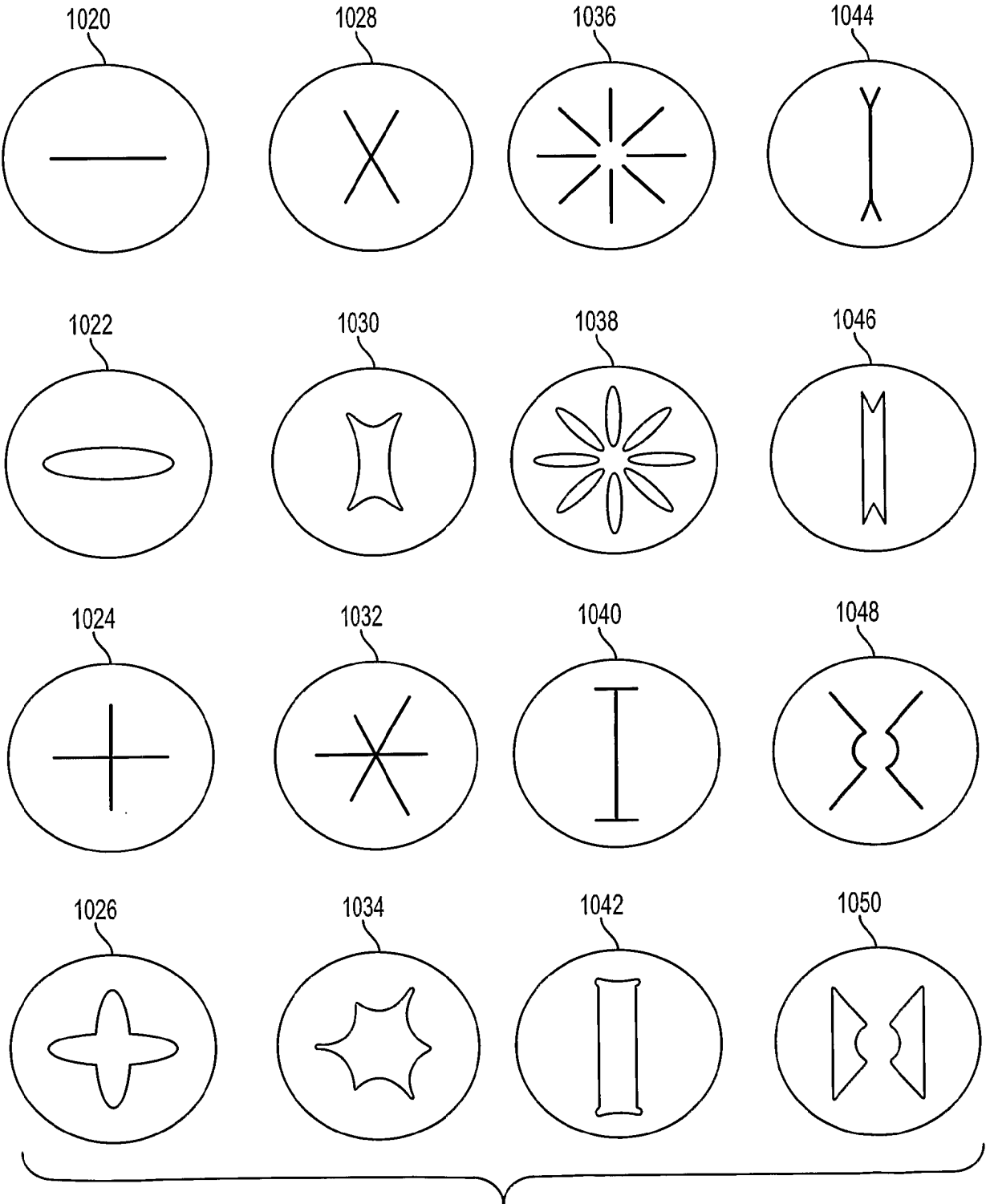


FIG. 10

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/10009

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B65D 37/00  
US CL : 222/212, 490, 494, 575

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 222/212, 490, 494, 556, 575

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,927,566 A (MUELLER) 27 July 1999 (27.07.1999), see entire document	1-20
A	US 5,676,289 A (GROSS et al.) 14 October 1997 (14.10.1997), see entire document.	1-20
A	US 4,969,581 A (SEIFERT et al.) 13 November 1990 (13.11.1990), see entire document.	1-20

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

28 May 2003 (28.05.2003)

Date of mailing of the international search report

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